Claims

1. A method for determining the concentration of a substance in a in-vitro or in-vivo specimen containing body liquid comprising the steps of

arranging a first electrode (18) at said specimen, wherein said first electrode is electrically insulated from the specimen,

applying a modulated electrical voltage to the first electrode for generating a modulated field in the specimen and

measuring at least one parameter (A, phi) depending on a response of the specimen to the field and determining the concentration therefrom.

2. The method of claim 1 comprising the step of arranging a second electrode (19, 22) at said specimen, wherein the modulated electrical voltage is applied between the first and the second electrode (19, 22).

3. The method of claim 2 wherein the second electrode (19, 22) is in electric contact with the body liquid in the specimen.

4. The method of one of the preceding claims further comprising the step of measuring a temperature (T) of the specimen and using the temperature in the determination of the concentration.

5. The method of one of the preceding claims wherein the modulated electrical voltage is a sine voltage.

6. The method of one of the preceding claims wherein the modulated electrical voltage has a frequency between 10 MHz and 2 GHz, in particular between 20 MHz and 70 MHz.

7. The method of one of the preceding claims wherein the parameter (A, phi, f0) depends on the electrical impedance at the first electrode.

8. The method of one of the preceding claims wherein the response of the specimen is measured by measuring a signal reflected from the first electrode.

9. The method of one of the preceding claims wherein an antenna electrode (33) is arranged at the specimen in proximity to the first electrode (18) and wherein the response of the specimen is measured by measuring a signal transmitted from the first electrode (18) to the antenna electrode (33).

10. The method of one of the preceding claims wherein the substance is glucose.

11. The method of one of the preceding claims wherein the specimen is a living body.

12. The method of one of the preceding claims comprising the step of using calibration data to convert the parameter (A, phi, f0) to the concentration.

13. The method of one of the preceding claims wherein the first electrode forms part of a resonant circuit (5) having a resonance frequency (f0) and wherein the resonant circuit (5) is operated substantially at the resonance frequency.

14. The method of claim 13 wherein the resonant circuit is at least part of a tank circuit of an active oscillator (40) and wherein the parameter is an amplitude (A) and/or a frequency (f0) of a signal generated by said oscillator (40).

15. The method of claim 13 wherein the modulated voltage is frequency sweeped from a frequency (fmin) below the resonance frequency (f0) to a frequency (fmax) above the resonance frequency, and in particular wherein the parameter is a signal reflected to the first electrode (18) or transmitted to an antenna electrode (33) at the resonance frequency (f0).

16. A device for determining the concentration of a substance in a in-vitro or in-vivo specimen containing body liquid, in particular for carrying out the method of one of the preceding claims, comprising

a first electrode (18) covered by a cover layer (29) of insulating material,

a signal source (1) connected to the first electrode (18) applying a modulated electrical voltage to the first electrode (18) for generating an electric field in the specimen,

a measuring circuit (7) for measuring at least one parameter depending on a response of the specimen to the field, and

a data processor (8) determining the concentration from the parameter.

17. The device of claim 16 comprising a holder (31) for fixing the first electrode (18) to a part of a body with the cover layer (29) facing the body.

18. The device of one of the claims 16 or 17 further comprising an electrically insulating substrate (17), wherein the first electrode (18) is arranged on a first side (20) of the substrate (17) between the substrate (17) and the cover layer (29).

19. The device of claim 18 further comprising a second electrode (19, 22) arranged on the substrate, wherein the signal source (2) is connected to apply the modulated electrical voltage between the first (18) and the second (19, 22) electrode.

20. The device of claim 19, wherein the second electrode (19, 22) comprises a bottom electrode layer (22) arranged on a second side (21) of the substrate (17), said bottom electrode layer (22) having a larger extension than said top electrode layer (18).

21. The device of one of the claims 19 or 20, wherein the second electrode (19, 22) comprises a top electrode layer (19) arranged on the first side (20) of the substrate (17), said top electrode layer (19) being arranged around at least part, in particular substantially all, of the first electrode (18).

22. The device of one of the claims 16 to 21, wherein the first electrode (18) is elongate having a width much smaller than a length.

23. The device of one of the claims 16 to 22 comprising a first (4) and a second (6) signal path between the signal source (1) and the measuring circuit (7), wherein the first electrode (18) in arranged in the first signal path (4) and a reference load (R3) is arranged in the second signal path (6), and wherein the measuring circuit (7) is adapted to measure a relative amplitude (A) and/or phase (phi) of signals from the first and second paths.

24. The device of one of the claims 16 to 23 wherein the first electrode (18) is part of a capacitor (C) of a resonant circuit (5) comprising the capacitor (C) and an inductance (L) connected to the signal source (1).

25. The device of claim 24 wherein the capacitor (C) and the inductance (L) are arranged in series.

26. The device of one of the claims 24 or 25 wherein the measuring circuit (7) is adapted to measure a voltage over the resonant circuit (5).

27. The device of one of the claims 24 to 26 further comprising an antenna electrode (33) arranged in proximity to the first electrode (18), wherein the measuring circuit (7) is adapted to measure a signal transmitted from the first electrode (18) to the antenna electrode (33).

28. A device for determining the concentration of a substance in body liquid of a human body, in particular of one of the claims 15 to 26, comprising

an elongate first electrode (18) having a width much smaller than a length,

a holder (31) for fixing the first electrode (18) to an arm or leg of a body with a longitudinal axis

of the first electrode being substantially parallel to the arm or leg

a signal source connected to the first electrode applying a modulated electrical voltage to the first electrode (18) for generating a modulated field in the specimen,

a measuring circuit (7) for measuring at least one parameter (A, phi, f0) depending on a response of the specimen to the field, and

a data processor determining the concentration from the parameter.